Refining Cascadia Earthquake Chronologies that Bracket a Candidate Segment Boundary, Southern Oregon:
Collaborative Research with Humboldt State University and
William Lettis & Associates, Inc.

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Investigations Undertaken

This research tests the hypothesis that the Cascadia subduction zone always ruptures the entire length (>900 km) of the plate interface. If this hypothesis is true, then stratigraphic records of coseismic subsidence along the length of the margin should reflect the same earthquake chronologies. We will compare the earthquake chronologies at two proposed study sites in southern Oregon to one another, and to the documented record of earthquakes in southwestern Washington (Atwater and Hemphill-Haley, 1997). Such comparisons will evaluate segmentation models and temporal patterns of earthquake recurrence. The results of our research will provide revised earthquake chronologies for the south-central Cascadia subduction zone (Figure 1), improve estimates on the range of earthquake recurrence intervals for plate-boundary earthquakes, evaluate whether earthquake chronologies reflect temporal clustering, and possibly resolve whether prehistoric great earthquakes have ruptured discrete segments of the plate boundary.

Results

In August 2002 we recovered five additional vibracores at the locations of cores J and V of our previous study in the lower Sixes River valley (Kelsey et al., 2002). Cores J and V provided the most complete and well-preserved stratigraphy of the 28 original cores sampled at the Sixes River. We re-examined cores J and V in late March 2003 and sampled eleven buried soils for detrital plant macrofossils that provide optimal material for ^{14}C dating. The sediment cores were split at the Humboldt State University sedimentology laboratory, photographed, and logged in detail noting the lithological characteristics of stratigraphic units, abruptness of unit boundaries, and depths to the top of buried soils.

The preliminary results of 15 radiocarbon analyses of delicate herbaceous seeds, conifer leaves, and twigs from nine different buried soils at the Sixes River site provided new age estimates to better constrain earthquake timing. Age estimates for three of the nine soils (soils VI, XI and XII) have been refined with these supplemental results. A new age estimate for submergence of soil IV, an event that was not dated during prior work, appears to be stratigraphically consistent with our published data. However, seven age estimates for samples from other soils appear to be too young based on stratigraphic constraints, and an additional age appears to be stratigraphically too old. All of the suspect age estimates resulted from analyses of very small (≤1-mm diameter) herbaceous seeds sieved from the uppermost horizons of buried soils. Our working hypothesis is that these seeds, too young in all but one case, have penetrated downward from younger stratigraphic horizons via bioturbation. Alternatively, these seeds may have sprouted and fixed modern carbon during sample processing. To test this hypothesis, we have submitted three additional samples of detrital macrofossils that include conifer needles and delicate twigs, that in the past have provided repeatable age estimates.

In June 2003, we recovered nine additional vibra cores from tributary valleys of the Coquille estuary. The sites revisited included cores I and M in the Sevenmile Creek valley and core O near Fahys Creek swamp. These sites, together, contained the most complete stratigraphic record of 12 coseismic subsidence events recognized during previous investigations at the Coquille study site (Witter et al., 2003). During this investigation the deepest core was recovered from core site M where we reached 6.1 m depth. The sediment cores were split at the Humboldt State University sedimentology laboratory, photographed, and logged in detail noting the lithological characteristics of stratigraphic units, abruptness of unit boundaries, and depths to the top of buried soils. Detrital macrofossils will be selected by sieving sediment samples from the upper contacts of buried soils and from sand deposits overlying the soils.

Accurate estimation of the time of soil submergence in the Coquille estuary requires a critical evaluation of the stratigraphic context of the fossil specimen submitted for ^{14}C analysis. Remaining funds provide for approximately twelve radiocarbon analyses to refine soil age estimates for the Coquille sites. Therefore, we will continue to carefully select and identify detrital plant macrofossils preserved near upper buried soil contacts, and carefully document the stratigraphic context and likely provenance of each fossil specimen in order to rank the samples and optimize the likelihood that the sample ages will closely estimate the time of soil burial. The following criteria will be considered when prioritizing fossil samples before submission for ^{14}C analysis: relative degree of decay, sample weight, macrofossil type, evidence for reworking, and stratigraphic context. Sample material from soils that will more directly test the research hypothesis will also receive a higher weight. Once the specimens are selected they will be submitted for AMS radiocarbon analysis and combined and calibrated using CALIB 4.3 (Stuiver and Reimer, 1993; Stuiver et al., 1998). Finally, the new ^{14}C age estimates generated by this study will be used to improve plate-interface earthquake chronologies for southern Oregon. Comparisons of the southern Oregon data with earthquake history from Willapa Bay in southwestern Washington will assess the likely correlation in time of earthquakes that may have ruptured the plate boundary from southern Oregon to southern Washington.

The results of this research will be used to refine the plate-boundary earthquake chronologies for the Sixes River and the Coquille estuary, two study sites that bracket a potential Cascadia subduction zone segment boundary. The results of our research will consist of new radiocarbon ages for coseismically buried soils to supplement our existing data set for southern Oregon. These radiocarbon ages will provide a better means for interpreting the synchroneity or non-synchroneity of events along the Cascadia subduction zone that ruptured the plate boundary between Willapa Bay and Cape Blanco. The results of this research will improve estimates of the range of recurrence intervals for plate-boundary earthquakes, evaluate whether earthquake chronologies reflect temporal clustering, and possibly resolve whether earthquakes have ruptured independent seismic segments of the plate boundary. Ultimately, these data will allow better evaluations of probabilistic seismic hazard models for the PNW and thus, will likely lead to reduced loss of life and infrastructure in future earthquakes on the Cascadia subduction zone.

Non-technical Summary

Geological and geophysical evidence suggest that the most recent Cascadia earthquake broke over 900 km during a magnitude 9 event. However, earthquake records from estuaries in southwestern Oregon suggest that not all events are of that size. This research focuses on two previously studied sites, Cape Blanco and Coquille estuary, that chronicle earthquake histories over the past 6,000 to 7,000 years. Further investigations will provide new data to improve earthquake records. Comparisons between these records and records from southwestern Washington will improve our understanding of the size of Cascadia earthquakes, how often they occur, and whether events cluster in time.

Reports Published

None to date.

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